ARJUNA

JEE

P.O.A.C. Method

x

LECTURE - 02

Atomic structure

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TABLE OF CONTENT

01 **Discovery of electron , proton and neutron**

02

03

04

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Q. Which has highest e/m ratio :

1 minutes

A $He^{2+} \rightarrow \frac{2}{4} = \frac{1}{2} = 0.5$

B $Li^{\pm} = \frac{1}{7} = 0.1$

C $Be^{2+} \rightarrow \frac{2}{9} = 0.2$

D $H \rightarrow \frac{0}{1} = 0$

${}_Z X^A$ A = Atomic Mass No.

Z ↓ Atomic No.

${}_3 Li^7$

$\frac{e}{m}$ ratio = specific charge ratio = $\frac{\text{Charge of species}}{\text{Mass of species}}$

${}_2 He^4$

${}_4 Be^9$ ${}_1 H^1$

Q select the particle which has max. value of $\frac{e}{m}$ ratio

(a) e^{-1} electron ✓ (b) H^{+} (proton) (c) α-particle (He^{+2}) (d) n (neutron)

Solⁿ electron — charge = 1, mass = $\frac{1}{1837}$ → $\frac{e}{m} = \frac{1}{\frac{1}{1837}} = 1837$

proton (H^{+}) → Charge = 1 mass = 1 → $\frac{e}{m} = \frac{1}{1} = 1$

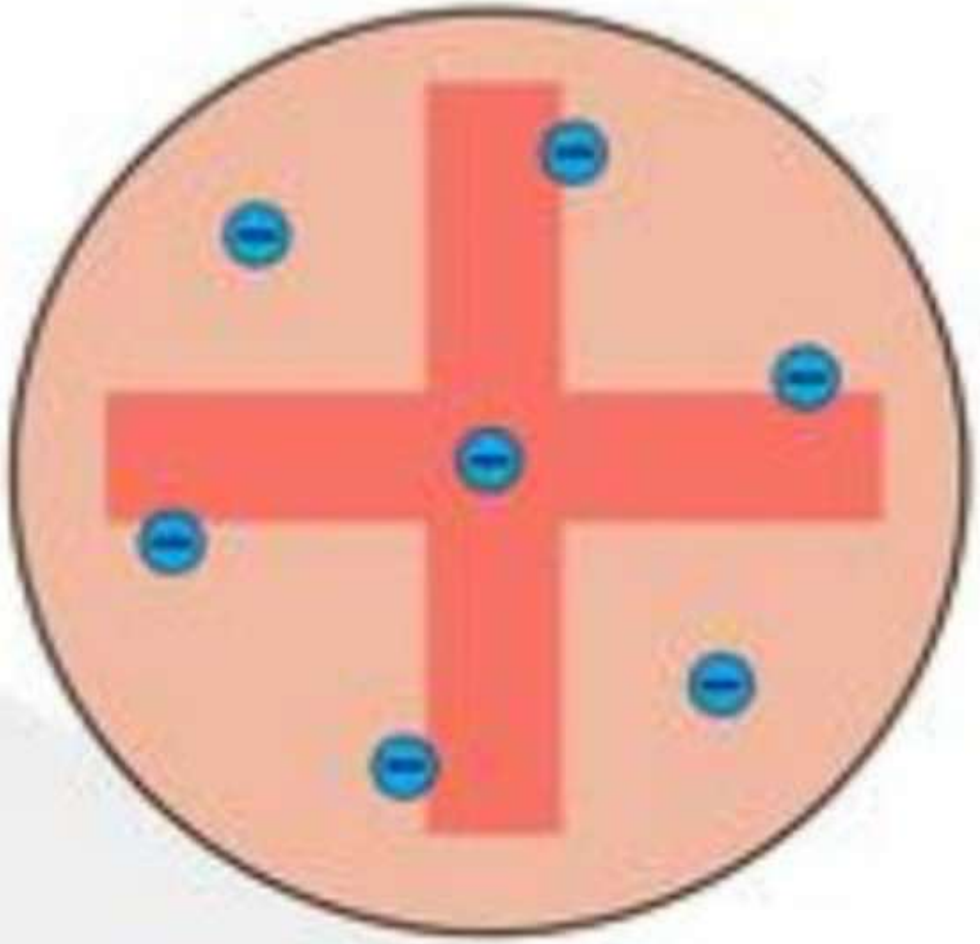
α-particle (He^{+2}) ⇒ Charge = 2, mass = 4 → $\frac{e}{m} = \frac{2}{4} = \frac{1}{2}$

${}_{2}He^{4}$

neutron (n^{0}) ⇒ Charge = 0, Mass = 1 → $\frac{e}{m} = \frac{0}{1} = 0$

Thomson's Model

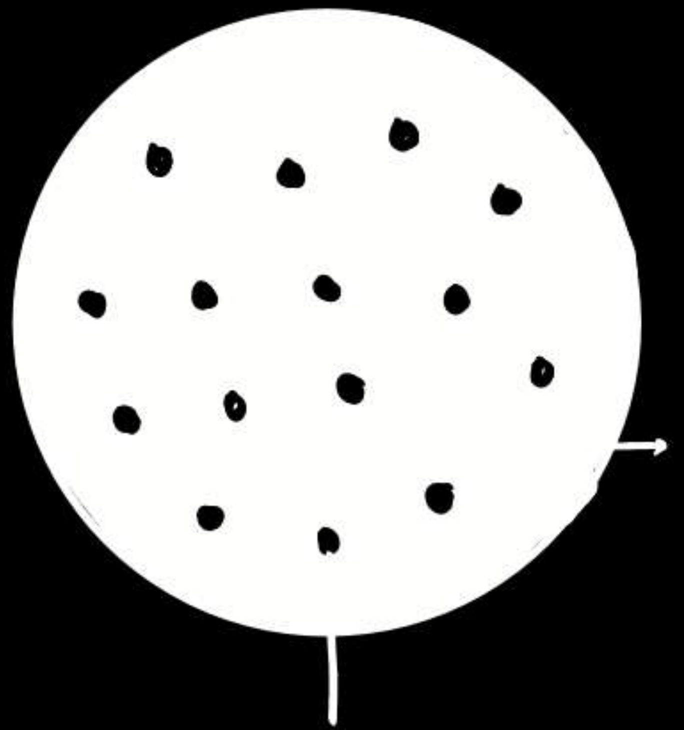
- In 1898, J. J. Thomson in proposed first model of atom. According to this model, the +ve charge of the atom is uniformly distributed throughout the volume of the atom and the negatively charged electrons are embedded in it like seeds in a watermelon. This model is also known as plum pudding model of the atom. This model was able to explain the overall neutrality of an atom.



- Limitations:

1) It could not explain the origin of spectral series of hydrogen and other atoms.

2) It could not explain large angle scattering of α – particles.



Limitation

1. does not explain arrangement of e^- in Atom
2. does not explain Stability of Atom

(1) Atom = spherical

(2) Mass uniformaly spread in complete spherical atom (prton)

(3) -ve charge (e^-) → embebbed in uniformaly spread Mass

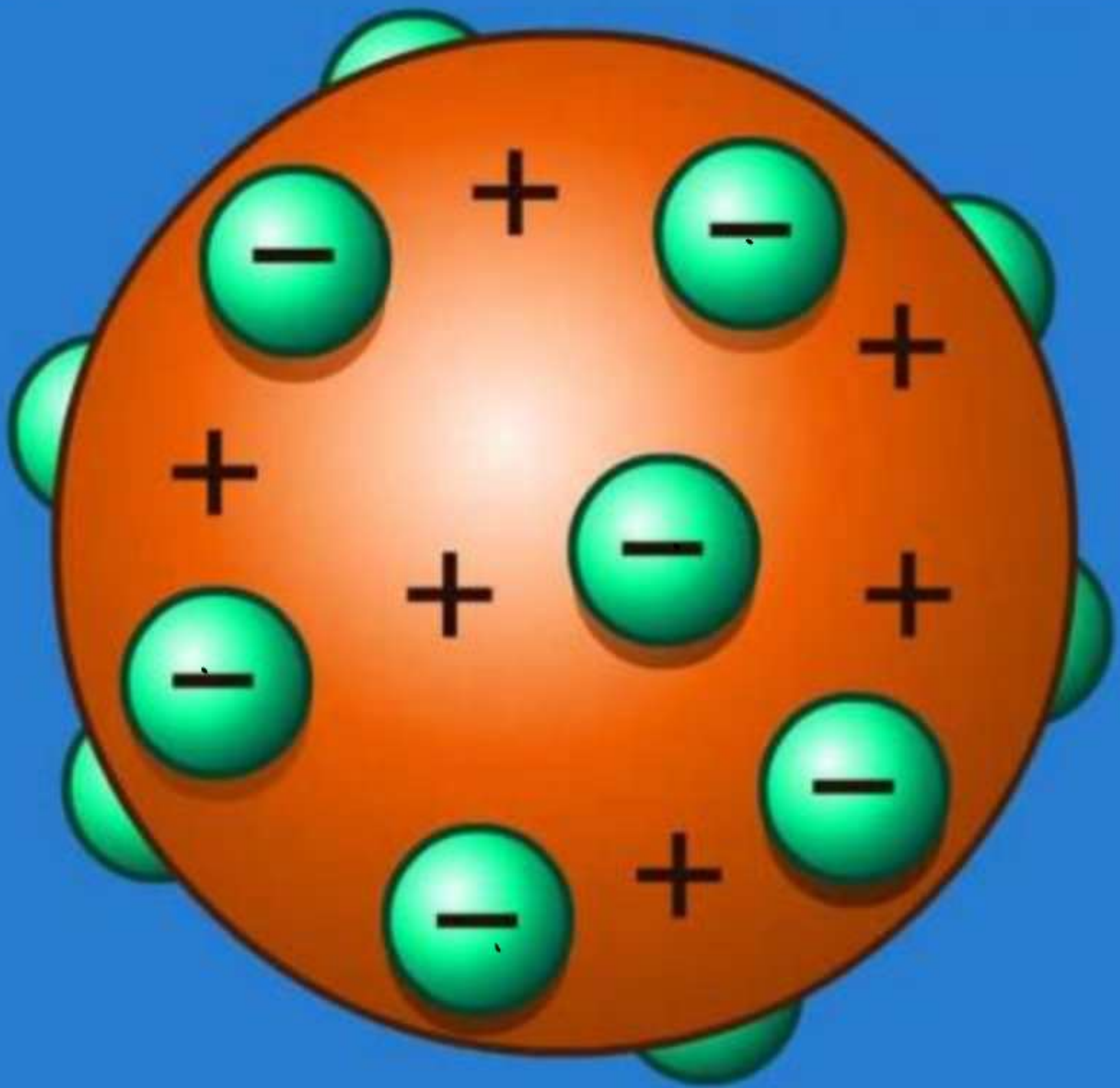
(4) Atom → neutral hota hai

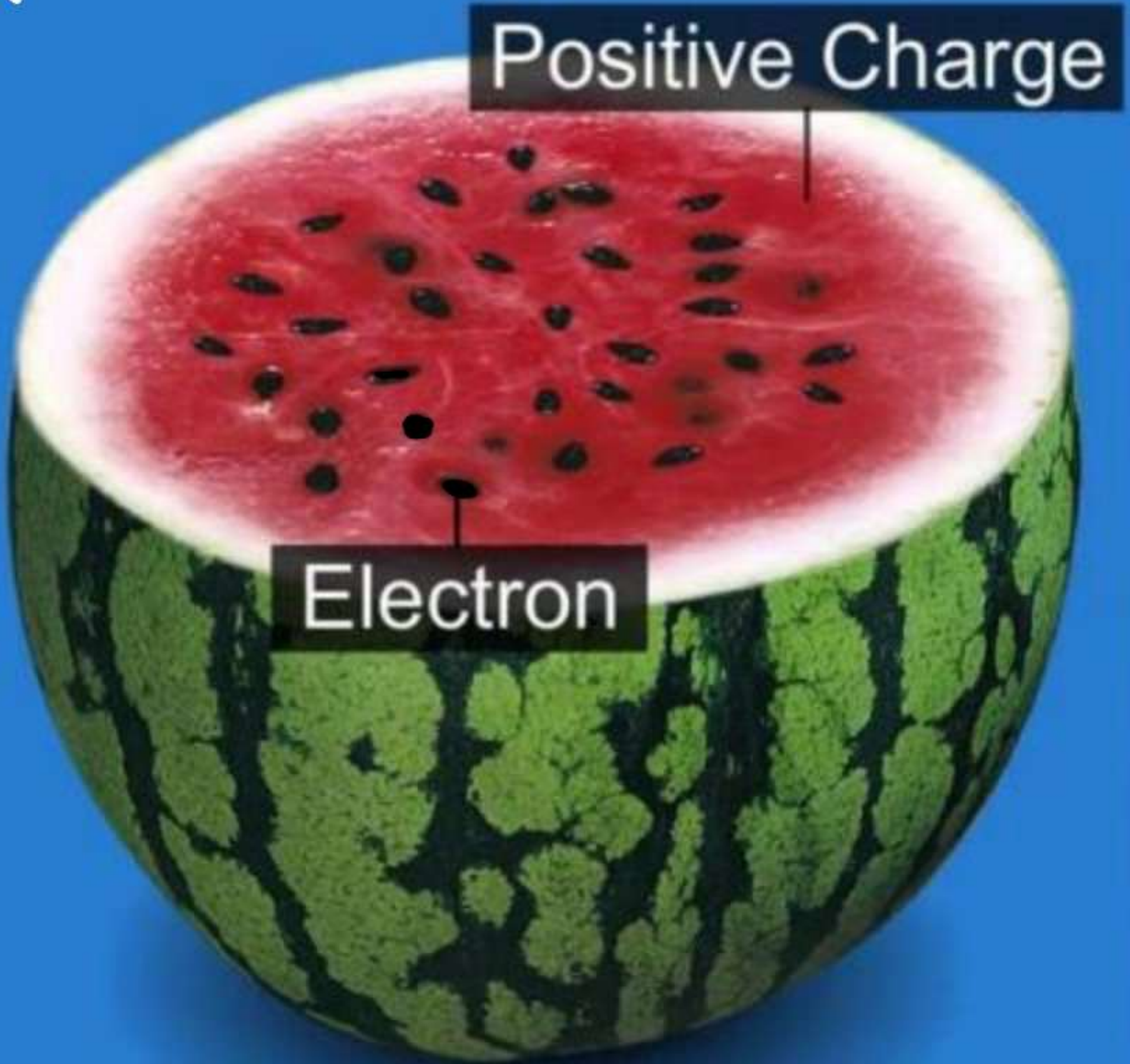
total +ve charge = total -ve charge

THOMSON'S ATOMIC MODEL

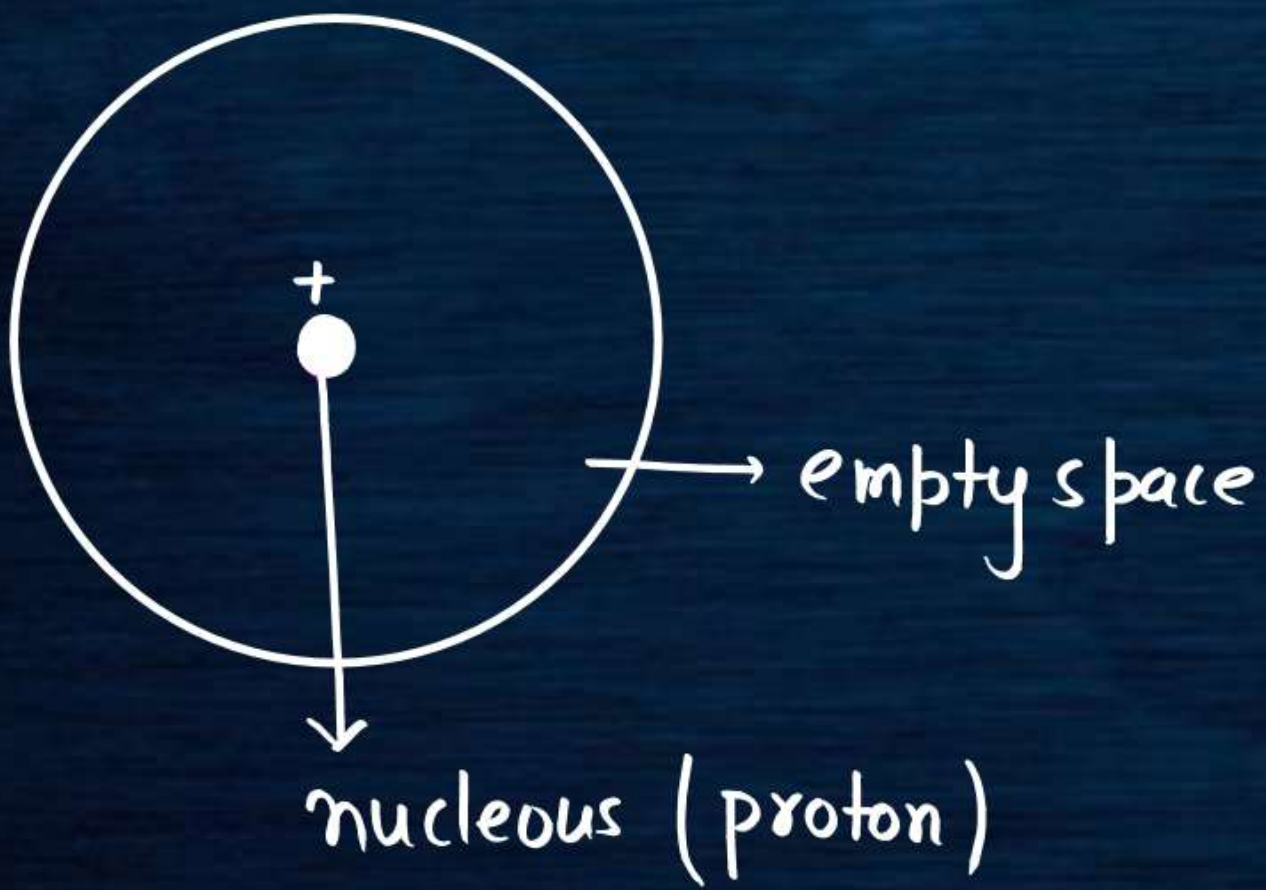
or

Atom Model plum pudding model or Watermelon model



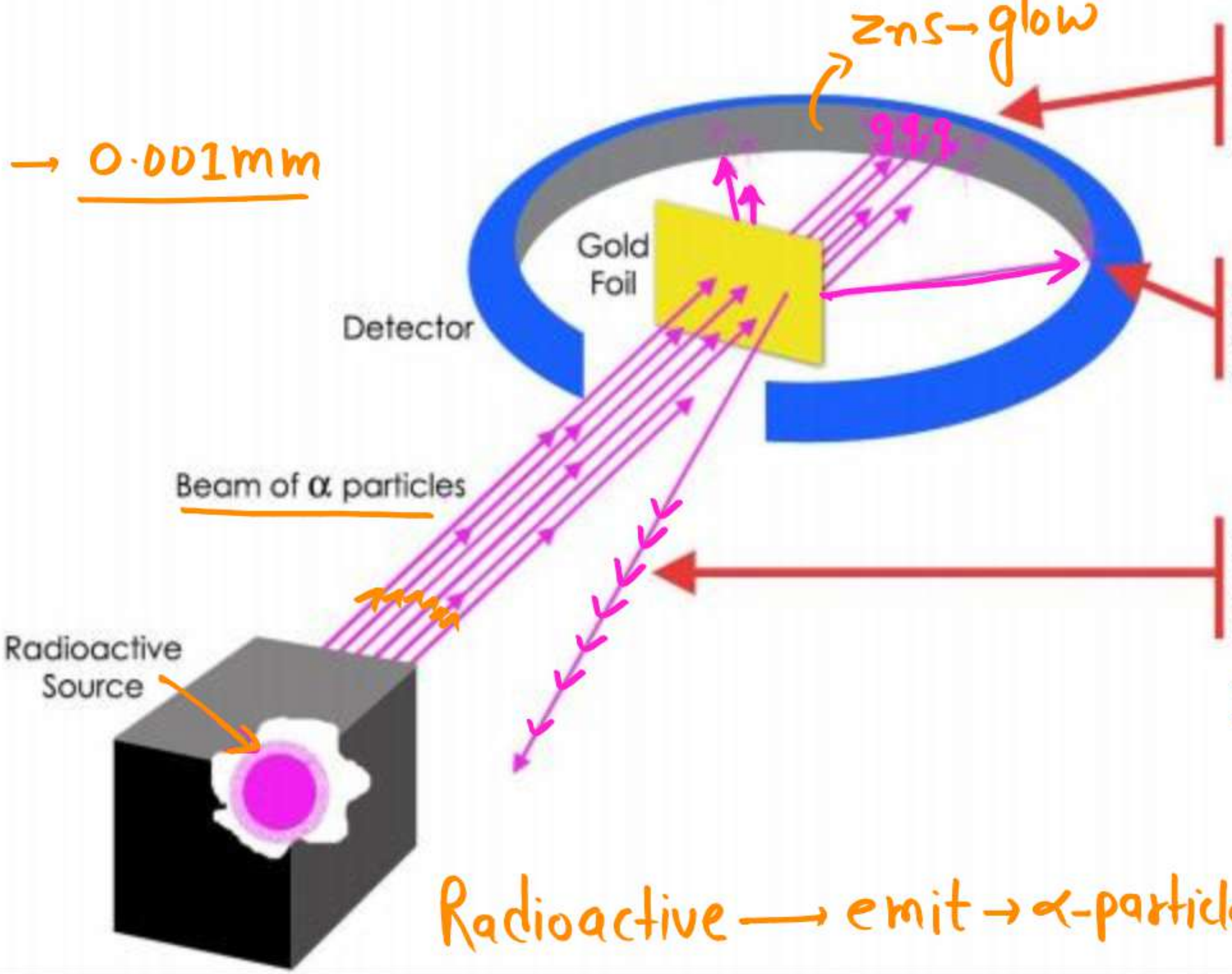


RUTHERFORD SCATTERING EXEPRIMENT



→ Discovery of nucleous

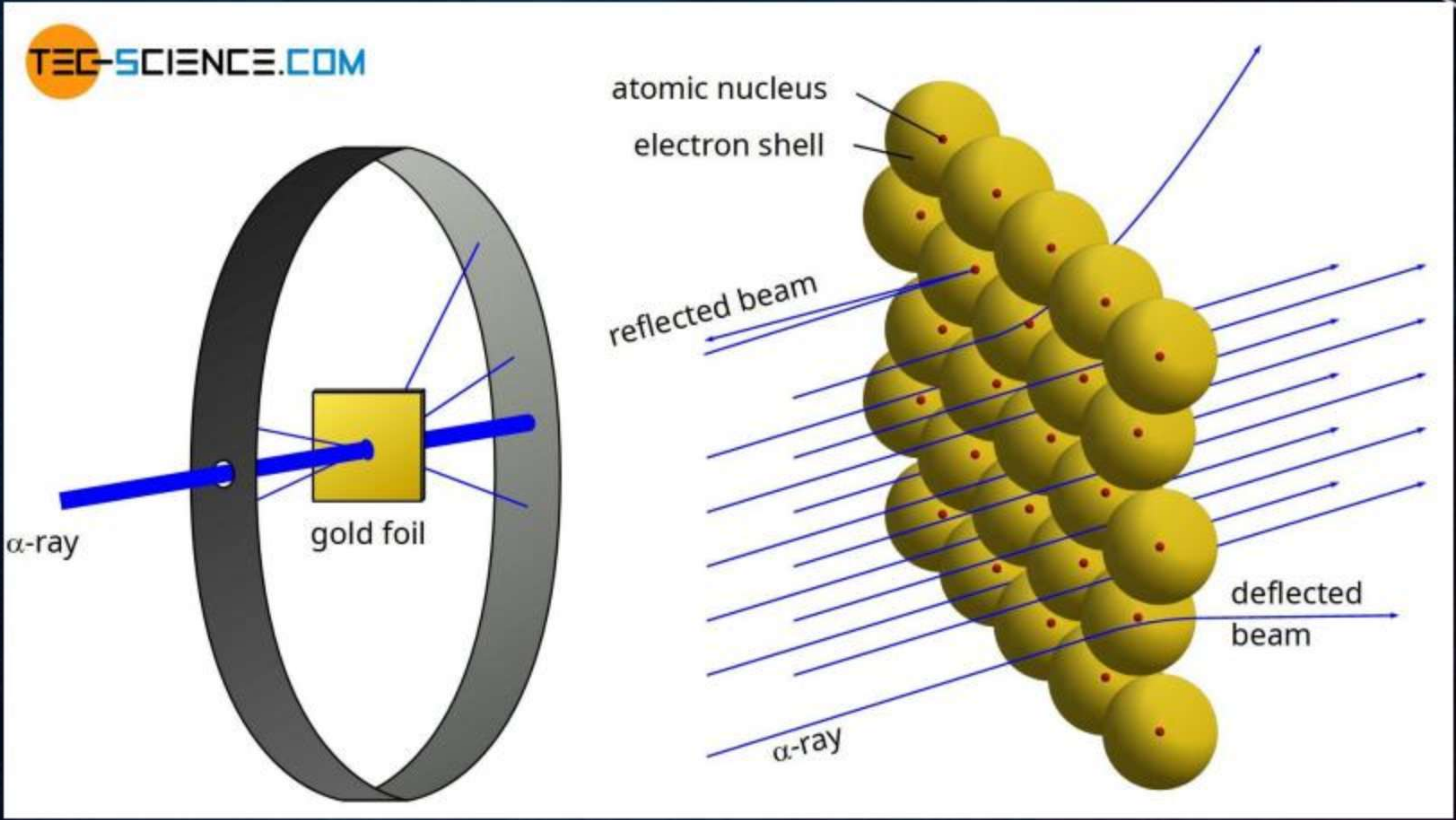
Rutherford's Gold Foil Experiment



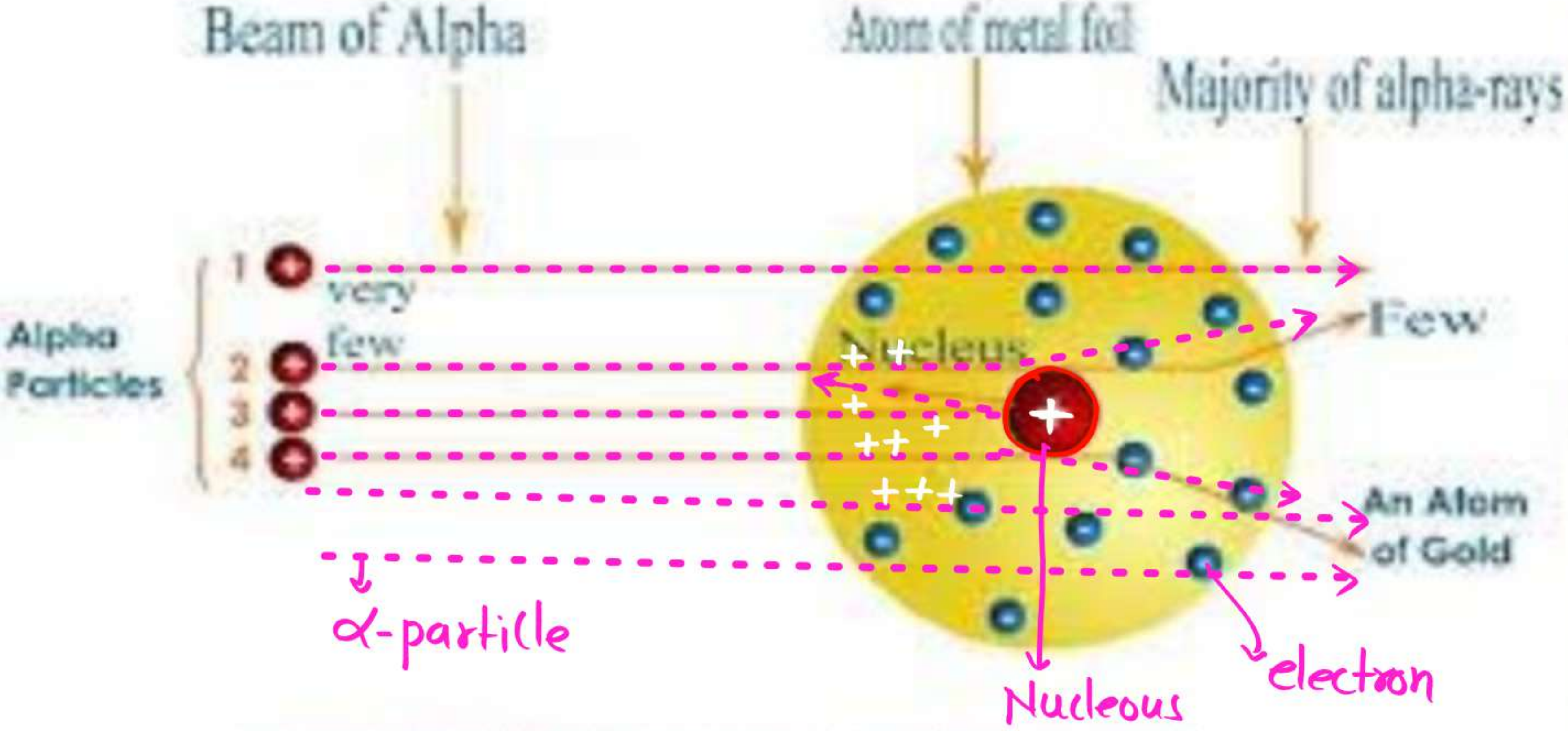
Radioactive ⟶ emit → α-particle

Observation	Interpretation
Most α particles travel through the foil undeflected 99.9%	① The atom is mostly empty space
Some α particles are deflected by small angles	② The nucleus is positively charged, as is the α particle
Occasionally, an α particle travels back from the foil	The nucleus carries most of the atom's mass

20,000 α → 1 α → bounce back



TEC-SCIENCE.COM
α-ray
gold foil
atomic nucleus
electron shell
reflected beam
deflected
beam
α-ray



Rurtherfords experiment of Gold metal foil

Rutherford Atomic model

(1) Atom → 2 part
- → Nucleous (p^+)
- → extra Nuclear parts (e^-)

(2) Radius of Nucleous = 10^{-15} m = 10^{-13} cm = 1 fm = 10^{-5} A^o

Radius of Atom = 10^{-10} m = 10^{-8} cm = 10^{-5} Fm

$C_{SD} = 3$

① Radius of nucleons (r_{Nu}) $= 1.4 \times 10^{-13} A^{\frac{1}{3}} = R_0 A^{\frac{1}{3}}$

where ⇒ A = Atomic mass of metal foil

② Compare b/w Radius of nucleons of two different atom

$$\frac{(r_{Nu})_1}{(r_{Nu})_2} = \left(\frac{A_1}{A_2}\right)^{\frac{1}{3}}$$

Q → Calculate Radius of Nucleous of gold foil $\left({}_{79}Au^{197}\right)$ — (A), (Z)

(a) $1.4 \times 10^{-39} \times 197$

✓ (b) $1.4 \times (197)^{\frac{1}{3}} \times 10^{-13}$

(c) $1.4 \times 10^{-13} \times (79)^{\frac{1}{3}}$

(d) None of these

$r_{Nu} = 1.4 \times 10^{-13} A^{\frac{1}{3}}$

$r_{Nu} = 1.4 \times 10^{-13} (197)^{\frac{1}{3}}$

Q Radius of nucleous of Atom-x is p A°
Calculate Radius of nucleous of Atom-y in term of p

Atomic Mass of X & Y atom is 10, & 20

(a) $r_y = p \times \frac{1}{2}$

(b) $r_y = p \times \left(\frac{1}{2}\right)^{\frac{1}{3}}$

(c) $r_y = p \times \left(\frac{1}{2}\right)^{-\frac{1}{3}}$

(d) None of these

$$\frac{(r_{Nu})_x}{(r_{Nu})_y} = \left(\frac{A_x}{A_y}\right)^{\frac{1}{3}}$$

$$\frac{p}{(r_{Nu})_y} = \left(\frac{10}{20}\right)^{\frac{1}{3}}$$

$$(r_{Nu})_y = \frac{p}{\left(\frac{1}{2}\right)^{\frac{1}{3}}}$$

$$= p \times \left(\frac{1}{2}\right)^{-\frac{1}{3}}$$

Q-1 ⇒ volume of Nucleous = $\frac{4}{3}\pi r_{Nu}^{3} = \frac{4}{3}\pi\left(1.4\times10^{-13} A^{\frac{1}{3}}\right)^{3}$

$$= \frac{4}{3}\pi \times \left(1.4\times10^{-13}\right)^{3}\cdot A$$

Q=2 → Mass of Nucleous ⇒ Atomic Mass Number Ke equal

$$(\text{Mass})_{Nu} = A\,\text{amu} = A\times1.67\times10^{-24}\,\text{gram}$$

Q=3 → density of Nucleous → (a) 10^{10} (b) 10^{15} (c) 10^{12} (d) 10^{5}
approx

$$(\text{density})_{Nu^-} = \frac{(\text{Mass})_{Nu^-}}{(\text{Volume})_{Nu^-}}$$

$$= \frac{\cancel{A} \times 1.67 \times 10^{-24}\ \text{gram}}{\frac{4}{3}\pi (1.4 \times 10^{-13})^3 \times \cancel{A}\ \text{cm}^3}$$

$$\simeq 10^{14} - 10^{15}\ \frac{\text{gram}}{\text{cm}^3}$$

Q-1 ⇒ Radius of atom approx = 10^{-10} m

Q-2 ⇒ Radius of nucleous approx = 10^{-15} m

Q → what fraction of volume occupied by nucleous in any atom approx.

(a) 10^{-3} (b) 10^{-5} (c) 10^{-10} (d) ✓ 10^{-15}

$$\text{Vol. occupied by Nu.} = \frac{\text{Vol. of Nucleous}}{\text{Vol. of Atom}} = \frac{\frac{4}{3}\pi\left(10^{-15}\right)^3}{\frac{4}{3}\pi\left(10^{-10}\right)^3} = \left(10^{-5}\right)^3 = \underline{\underline{10^{-15}}}$$

Q. Rutherford's scattering experiment is related to the size of the ______

A nucleus ✓✓

B atom

C electron

D neutron

Q. The atomic nucleus contains ______.

[1988, 1M]

A protons

B neutrons

C electrons

D photons

Q. Rutherford's experiment on scattering of α-particles showed for the first time that the atom has ______.

[1981, M]

A electrons

B protons

C nucleus

D neutrons

Q. The radius of an atomic nucleus is of the order of ______.

(1985, 1M)

A 10^{-18}

B 10^{-13} cm

C 10^{-15} cm

D 10^{-3} cm

10^{-15} m

Q. When alpha particles are sent through a thin metal foil, most of them go straight through the foil, because ______.

[1984, 1M]

A alpha particle are much heavier than electrons

B alpha particle are positively charged

C most part of the atom is empty space

D alpha particles move with high veloctiy

Q. When alpha particles are sent through a thin metal foil, most of them go straight through the foil, because _____. [1984, 1M]

A. alpha particle are much heavier than electrons

B. alpha particle are positively charged

C. most part of the atom is empty space

D. alpha particles move with high veloctiy

Q. Rutherford's experiment, which established the nuclear model of the atom, used a beam of ______. [2002, 3M]

A β-particles, which impinged on a metal foil and got absorbed.

B γ-rays, which impinged on a metal foil and got scattered.

C helium atoms, which impinged on a metal foil and got scattered.

D helium nuclei, which impinged on a metal foil and got scared .

α-particle $= ({}_2He^4)^{+2} \rightarrow$ nucleous of He-atom is know as α-particle

Q. Rutherford's alpha particle scattering experiment eventually led to the conclusion that ______.

(1986, 1 M)

A. mass and energy are related.

B. electrons occupy space around the nucleus.

C. neutrons are buried deep in the nucleus.

D. the point of impact with matter can be precisely determined.

Q. What fraction of volume occupied by nucleous in an atom approx

A. 10^{-18}

B. 10^{-10} cm

C. 10^{-15} cm

D. 10^{-8} cm

Home work

DPP No = 1

Thank - You